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ABSTRACT

This paper deals with three areas concerning early vocal development: (1) review and critique of existing experimental evidence suggesting that early vocal behavior has the properties of an operant response, (2) speculations concerning the role of non-verbal vocal behavior in early psychological development, and (3) suggestions for future research. Skinner's "Verbal Behavior" takes the position that verbal behavior could be analyzed within operant conditioning frameworks. Chomsky argues that the system which Skinner proposes is too simplistic to account for the intricacies of human speech. Other work reviewed covers conditioned vocal responses, conditioned response differentiation, reinforcer effectiveness, and the relationship between age and conditionability. Speculation about the role of early vocal responses includes a discussion of Watson's hypothesis that the human infant is structured from birth for the processing of response-contingent information and that at least two response-contingent sequences must occur within the infant's memory span in order for him to develop an initial awareness that his responses resulted in the change in external stimulation. It is suggested that the role of response-contingent stimulation on vocal development and its long-term consequences on vocal behavior warrants further investigation. (CK)

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The Role of Prelinguistic Vocalizations in Infancy

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The Role of Prelinguistic Vocalizations in Infancy

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Introduction

Theories of speech acquisition have paid scant attention to the function of the child's vocal behavior before the time that he can utter recognizable words. Yet it is during the period of prelinguistic vocal behavior that the conditions which affect the onset and continuation of speech development might be most readily observed. Although a substantial body of research exists concerning the phonetic and phonemic development of the infant's speech sounds, the work is primarily of a descriptive nature rather than of an explanatory one. More effort has been expended trying to classify and codify speech products than has been expended in trying to determine the factors that tend to enhance or retard early vocal production.

One question often asked by psychologists and parents alike is, what is the relationship between early vocal output and later vocal production? Unfortunately we have extremely little information with which to answer this question, and what information does exist seems to indicate no relationship (e.g. Winitz and Irwin, 1958 a). However, the type of measures which have been chosen to examine the relationship have been very limited with respect to those potentially usable. Winitz & Irwin, for example chose to examine phoneme types and phoneme frequencies that occurred in 30 breath sampling periods periodically taken over the first two and one-half years.

Several studies (e.g. Kareltz, Fisichelli, Costa, Karelitz, and Rosenfield, 1964; Cameron, Livson, and Bayley, 1967, and Spiker and Irwin, 1949) have related early vocal production to later intellectual development with somewhat mixed results. In general, a small positive relationship seems to exist between the two with perhaps a stronger relationship for females than for males.

However, the actual tracing of the processes or mechanisms which account for such relationships remains unaccomplished.

In general this paper will attempt to deal with three areas concerning early vocal development. First I will attempt to review and critique the experimental evidence that exists which suggests that early vocal behavior has the properties of an operant response and can thus be modified by response-contingent stimulation. Second I would like to advance some speculations concerning the role of non-verbal vocal behavior in early psychological development. And thrid, I would like to suggest some areas for future research.

Operant Conditioning Approach to Early Vocal Behavior

An increasingly influential approach to early speech development has grown out of the ideas that Skinner (1957) advanced in Verbal Behavior. Chomsky (1959) in his very influential review of that book severely criticized Skinner's position that verbal behavior could be analyzed within an operant conditioning framework, using such concepts as reinforcement, stimulus control, response differentiation, etc. Whereas Chomsky acknowledged that the insights that had been gained in laboratory experimentation with infra-humans were quite "genuine" he added that they "can be applied to complex human behavior only in the most gross and superficial way, and that speculative attempts to discuss linguistic behavior in these terms alone omit from consideration factors of fundamental importance . . . ." [p. 28] Chomsky concludes the paragraph which includes the above quotation by commenting on the fruits of the book's efforts. He asserted that "The magnitude of the failure of this attempt to account for verbal behavior serves as a kind of measure of the importance of the factors omitted from consideration, and an indication of how little is really known about this remarkably complex phenomenon." It appears that the line of attack which Chomsky has chosen to make is, at least in part, somewhat misdirected. His argument in essence is that the system which Skinner proposes is too simplistic to account for the intricacies of human speech.

What Chomsky apparently fails to realize is that Verbal Behavior is in the main a statement of a thesis. The thesis must stand or fall on the basis of the evidence that is generated by it. As MacCorquodale (1970) points out, "Although his thesis is empirical, Skinner's book has no experimental data involving the laboratory manipulation of verbal responses which definitely demonstrate that the processes he invokes to explain verbal behavior are in fact involved in its production . . . " [p. 84]. Whether or not Skinner's method of approach to verbal behavior is potentially useful in accounting for the full range of adult speech is still an unanswered empirical question and is in any event, beyond the scope of the present paper. It is interesting to note, however,that Skinner (1957) did assert that, "The process of 'operant conditioning' is most conspicuous when verbal behavior is first acquired." [p. 29] and it is to that period that we shall confine ourselves.

Conditioned Vocal Responses

In the almost 15 years since the publication of Verbal Behavior there has been an ever increasing amount of research on vocal behavior of infants using operant methodology.

The first successful attempt to increase vocal output using operant techniques was reported by Rheingold, Gewirtz and Ross (1959). Using 21 institutionalized infants with a median age of 3 months, those investigators reinforced discrete voiced sounds other than "straining sounds and coughs, and the whistles, squeaks, and snorts of noisy breathing." Although the reinforcement was consistent and unvarying it did not differ from what any mother might do when her baby vocalizes. That is, the experimenter simultaneously smiled, touched and vocalized back to the child when the child vocalized. Each day the children were to have three 9 minute sessions, with two days each devoted to baseline, conditioning, and extinction. (In this study, as with others to be reported in this paper, response rate will be converted to responses per minute [RPM] when feasible in order to provide maximum comparability across experiments). With this procedure, response

rate rose from initial baseline measures (E present but unresponsive to the infant) of slightly less than 5 responses per minute to slightly more than 8 responses per minute and dropped to about 5 responses per minute during extinction. As the authors pointed out, however, the demonstration that the alleged reinforcing stimulus had led to operant conditioning had not been completely accomplished. It is possible that it was not the contingent relationship between the vocal response and the social reinforcement that caused the response rate increase but, rather, that the alleged reinforcing stimulus was, in whole or in part, a releasing stimulus for the response in question.

In an attempt to address himself to the issue of whether the social stimulus was a reinforcing stimulus or a releasing stimulus Weisberg (1963) set up a widely known experimental situation using children of the same age and from the same institution as Rheingold et al. in which one experimental group was reinforced with the same reinforcer that had been used by Rheingold et al. This group was compared to another which received the same reinforcing stimulus but which had the social stimulation presented non-contingently with respect to the infants' vocal behavior. Two other experimental conditions by Weisberg are also of interest. One consisted of contingently presented non-social stimulation (a door chime); whereas, the other condition presented the door chime non-contingently.

Analysis of Weisberg's results demonstrated that only the Contingent Social Stimulation group was significantly affected during conditioning. Its response rate increased from approximately 1 RPM to slightly less than 3 RPM during conditioning and declined to approximately 2 RPM during extinction. Thus, whereas there are large response rate differences between those found in Weisberg's experiment and those reported by Rheingold et al., the general trend of Weisberg's data tends to support the notion that contingent social stimulation acts as a positive reinforcer for vocalization rather than as a releaser for that behavior. One other experimental condition that Weisberg used suggested that the mere presence of an unresponsive male stranger did not affect vocalization rates of infants.

More recently Todd and Palmer (1968) have presented evidence which indicates that although the mere presence of a male stranger may not affect infants' vocalization rates his presence may serve to increase the effectiveness of other reinforcers. Using institutionalized infants between 75 and 100 days of age, they attempted to condition two groups of 8 infants each using 5 second tape recordings of an adult female voice which began 1.5 seconds after vocal termination. In one of the two experimental conditions E was present (EP) while the reinforcing stimulus was presented and in the other condition he was never present (NEP). Each S was given 6 separate 10 minute sessions each for baseline (NEP), conditioning (NEP vs. EP), and extinction (NEP). The NEP group showed a significant increase from mean baseline frequency (approximately .5 RPM) to asymptotic conditioning frequency (approximately 1.7 RPM). The corresponding figures for the EP group are approximately .5 RPM and 3.2 RPM respectively. During the extinction sessions the response rates for both groups gradually approached the baseline rate. Although the sparse way in which the results are reported preclude unequivocal judgment, it appears that the frequency of responding during conditioning for the EP group was significantly higher than for the AP group, leading Todd and Palmer to conclude that whereas "Human presence is not a necessary factor in conditioning infant vocalizations, . . . it functions to increase the reinforcing effectiveness of the human voice." [p. 595]

The depressed rates of vocalization that both Weisberg and Todd and Palmer report, relative to those reported by Rheingold, Gewirtz and Ross demand explanation. One possible explanation for this discrepancy has been suggested by Weisberg. In comparing his experiment to that done by Rheingold et al. he observed that, whereas the later investigators had worked with their Ss in the infants' own cribs he had used an experimental room. From Todd and Palmer's description of their procedure it appears that they also used a novel setting [an experimental crib]. It is therefore possible that the relative novelty of these situations produced response inhibition of vocalization.

Another possibility for Todd and Palmer's rate reduction may be derived from a recently reported experiment by Ramey and Ourth (1971) concerning the

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effects of delayed social reinforcement. Using 15 normal home-reared infants at each of three age levels (3, 6, and 9 months) they demonstrated that when reinforcement was delayed by as little as 3 seconds, conditioning did not occur for any of the age groups used. However when reinforcement was delivered by E (in a novel experimental situation in the presence of the infant's unresponsive mother) mean response rate increased from approximately 2 RPM during baseline to an asymptote of approximately 7 RPM during conditioning and declined to approximately 2 RPM during extinction within a single nine minute conditioning session. Thus Todd and Palmer's relative rate reduction which was gathered using a 1.5 second delay might conceivably be due, in part at least, to the negative effects of delayed reinforcement.

Conditioned Response Differentiation

The attempts to condition infant vocalizations which have been mentioned so far have all concerned themselves with non-selectively increasing the frequency of emission of all vocal sounds other than crying, fussing, coughing, hiccoughing or other such sounds which typically are not considered part of babbling. However, one of the major tenets of the learning theory approach to vocal behavior is that the vocal repertoire of early childhood speech can be partly accounted for by selective reinforcement of a subset of all the vocal sounds that an infant can make [see Miller and Dolland (1941), Mower (1950) and Skinner (1957)]. (It should be noted that whereas, there appears to be a general and probably well founded assumption among psychologists that there are no significant differences in the initial vocal repertoires of young infants in different cultures these authors have been unable to find any good empirical evidence to support this very claim. Given the importance of such an assumption more good cross cultural psycholinguistic research seems to be in order). Routh (1969) has, however, provided some experimental evidence to suggest that the frequency of utterance of vowels and consonants can be selectively affected by differential reinforcement for infants between 2 and 7 months of age. In this carefully conducted experiment using 23 home-reared infants and 7 institutionalized babies he maintained 3 experimental groups which included the following

conditions: (1) reinforcement of all discrete vocalizations, (2) reinforcement of consonants only and (3) reinforcement of vowels only. The reinforcement was the same as that used by Rheingold et al. and consisted of a smile, three "tsk" sounds and simultaneous pressure on the infant's abdomen. Experimenter-observer reliabilities during conditioning of .97 for vocalization, .81 for consonants, and .95 for vowels were reported. Although there was a general increase in the frequency of both vowels and consonants under all experimental conditions there was a greater proportional increase of vowels in the vowel-only reinforcement condition and a greater proportional increase of consonants in the consonant-only reinforcement condition leading Routh to conclude that "it appears that not only the total rate of vocal production but also the qualitatively specific components of infant vocalizations may be modified by conditioning procedures." [p. 225]

With respect to Routh's data several findings seem particularly interesting. First, although it is somewhat difficult to determine with precision from the presentation of results what the overall mean RPM for vocalization was for each of the three groups, it appears that the asymptotic conditioning rates are quite significantly above those reported by Weisberg (1963) and Todd and Palmer (1968) and similar to those reported by Rheingold et al. (1959) and Ramey and Ourth (1971). At least two possible explanations for Routh's high response rates relative to Weisberg's and Todd and Palmer's suggest themselves. (1) Routh used mainly home reared infants who may differ somewhat in vocalization rates from institutionalized children (see, for example, Brodbeck and Irwin, 1946, Goldfarb, 1943; and Dennis and Najarian, 1957 for supporting information). (2) From a footnote in Routh's paper it appears that the home-reared children were conditioned in their own homes which may have reduced the probability or magnitude of vocal response inhibition due to a completely new experimental situation such as that used by Weisberg and Todd and Palmer.

The second point to be emphasized is the overall increase in all vocalizations in the two groups in which only a subclass of all vocalizations was reinforced. Routh explains this general increase using the principle of response generatlization.

Recently Ramey, Hieger, and Klisz (1971) have reported an analogous finding (which will be detailed later in this paper) with maternally deprived infants who were vocally retarded. In this latter experiment there was an apparent increase in intensity and complexity of vocalization even though any non-fussy vocal response of minimal intensity was sufficient for reinforcement to be delivered.

Reinforcer Effectiveness

Schwartz, Rosenberg, and Brackbill (1970) currently have the only published experimental evidence concerning comparative reinforcer effectiveness for vocalizations in infancy. They attempted to analyze the relative effectiveness of the components of the social reinforcement that has been most frequently used (i.e., reinforcement patterned after that used by Rheingold, et al.). The components of the social reinforcement are (1) visual stimulation, (2) tactile stimulation, and (3) auditory stimulation. The visual reinforcement consisted of the experimenter's smiling and nodding his head, the tactile of the experimenter's rubbing the infant's abdomen with the palm of his hand, and the auditory of a one second tape recording of a female's voice saying "nice baby."

Two experiments were conducted with one using 16 institutionalized infants and the other using 12 institutionalized infants. The first experiment had 4 experimental conditions with 3 of them consisting of the 3 pair-wise combinations of the separate components. The fourth condition was similar to that used by Rheingold et al. (1959) and consisted of all three components presented simultaneously.

The second experiment focused on single component reinforcers.

Conventional baseline, conditioning, and extinction procedures were used in both experiments with two 20 minute sessions devoted to baseline. The criterion for conditioning was somewhat different than that used in previous experiments and warrants comment. An infant was judged to have been conditioned when he "had achieved a vocalization rate at least 2.5 times that of his baseline rate and had sustained it for 5 consecutive minutes or until

three consecutive 20-minute sessions (60 minutes) had passed without the infant's reaching this criterion. Each S's score was the number of minutes taken to reach criterion." [p. 323] Although this type of criterion may prove very useful to investigators using operant techniques, it would be highly desirable to devise a way to assign a probability statement to the likelihood of a given percentage increase over baseline responding. Otherwise one is left with a somewhat arbitrary criterion for conditioning.

Analysis of the results from both experiments indicated that conditioning had occurred in all seven experimental groups but that there were no significant differences among the groups implying that no one of the reinforcing events is more effective than another.

As part of a larger research project, Ramey and Watson (1970) subjected 23 10-week old infants and 27 16-week-old infants to operant conditioning procedures designed to investigate the effectiveness of non-social reinforcement on male and female infants' vocalizations. All infants were from upper middle class backgrounds and were home reared. The procedure involved 1-minute of baseline, 4-minutes of conditioning and 2-minutes of extinction. Infants were reinforced with either a 1-second presentation from a light mounted in the center of a bullseye and a 1-second presentation of a 1000 cps tone simultaneously or recieved the light alone. The results indicated no change from baseline for the 10-week-olds under any of the experimental conditions. However, at 16-weeks there was a significant increase in the mean vocalizations from baseline performance to the last minute of conditioning from 3.88 RPM to 6.00 RPM respectively ($t = 2.354$, $d.f. = 26$, $P < .025$). When the results were broken down by sex and type of reinforcement, however, it was observed that the increase was due primarily to the males under the light-only reinforcement condition who increased from a mean of 3.38 RPM during baseline to a mean of 9.20 RPM during conditioning ($t = 6.05$, $d.f. = 4$, $P < .005$). Although the other mean baseline to terminal conditioning scores were in a positive direction they failed to reach statistical significance. Watson (1969) has reported a similar sex by reinforcement modality interaction using a different

operant response (visual fixation) which indicates that boys condition under visual reinforcement but not auditory (1000 cps tone), whereas girls condition under auditory but not visual reinforcement. Whereas his finding for males is consistent with the results just presented the finding for females is not (Ramey and Watson's female infants did not condition under either the light-only or the light plus tone) and it may be that the light in the light plus tone condition was somewhat aversive to the females serving to weaken the overall effectiveness of the compound reinforcer. In any event the results by Ramey and Watson (1970) and those of Watson (1969) (by extrapolation) appear inconsistent with those reported by Schwartz, Rosenberg, and Brackbill (1970) using social reinforcement and demand further research.

Age and Conditionability

Most of the experiments that are in the conditioning literature have in large part ignored chronological age as a factor in vocal conditioning. Indeed the bulk of the literature seems to have followed the precedent set by Rheingold, Gewirtz, and Ross (1959) and concerns itself with infants who are approximately 3 months of age. There appears to be an assumption that before about three months of age the vocal response is primarily under biological-maturational control and that environmental stimuli are of minimal influence.

Perhaps the most influential study that is cited to support the maturational viewpoint was conducted by Lenneberg, Rebelsky, and Nichols (1965). These investigators conducted a longitudinal study from birth to three months on 16 subjects. Five boys and one girl were born to deaf parents and three girls and seven boys were born to hearing parents. The specific problem to be addressed was "to what extent are the infant's earliest vocalizations dependent upon properly timed vocalizations [reinforcement](1) from his parents?" [p. 24] The working assumption appears to be that because deaf parents cannot hear their infant's vocalizations they are less prone to respond to them vocally and that this being the case the infants are not likely to have vocalization rates

(1)author's paraphrase

similar to babies of hearing parents unless those rates are controlled primarily by maturational factors rather than by reinforcement.

The basic data for this study were derived from 24 hour tape recordings made in the infant's homes approximately every two weeks for a three-month period. From the tape recordings infant vocalizations were recorded into 6 categories, three of which (cooing, arhythmic crying, and fussing) were subjected to statistical analyses comparing infants of deaf and hearing parents. Data were analyzed by dividing each hour into 10 6-minute intervals and determining whether any sounds that were judged to belong in the 6 categories had occurred within that interval. Frequencies of sounds or durations of sounds were not recorded and the statistical analysis consisted of comparing the "percentages of sampling periods,[2] not percentages of real time" in which categorizable responses occurred. A similar categorization procedure was used for environmental sounds. The results indicated no significant differences between the infants of deaf and hearing parents in vocalizations. The environmental sound analysis "brings out a statistically significant difference between the two groups with less amount of speech in the immediate surrounding of babies of deaf parents than of hearing parents." [p. 30]

With respect to infant vocalizations the authors conclude that "Our findings indicate that occurrence of individual cooing response are not contingent upon specific acoustic stimuli. If they were, babies of deaf mothers, who cannot get the proper reinforcement at the right time because the contiguity between mother's and child's vocalizations is absent or very deficient, should be abnormal in their cooing behavior. On the other hand, our findings can be explained by postulating a readiness to make cooing responses as a function of physical maturation; once the readiness is present the response may be elicited by a variety of stimuli . . ." [p. 35].

It appears that these conclusions are open to criticism.

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[2] Italics in original

First, although there is a statistically significant difference between the percentage of intervals in which voices were recorded close to the infants, favoring the infants of hearing parents, this relationship is far from indicating that deaf parents never vocalized during proximity to their children. In fact on 3 of the 7 blocks of experimental days which were plotted [Fig. 2 in Lenneberg et al.] the percentage data is in favor of the deaf group and on two other blocks there is only a slight difference favoring the hearing group. In any event, because of the way in which the data were analyzed it is absolutely impossible to speak of contingency relationships between the child's vocalizations and the mother's vocalizations except by the grossest speculations. But even with the significant statistical difference in mind, it is conceivable that although there was a difference in favor of the hearing group, a threshold for contingent vocal stimulation necessary for conditioning to have occurred, had been exceeded by the deaf parent group and that they were simply on a higher variable ratio schedule of reinforcement.

Second even if it were the case that the children of deaf parents were not receiving as much vocal reinforcement from their mothers there is a strong possibility that they were receiving other kinds of reinforcement. In the method section of their paper Lenneberg et al. noted that:

"All deaf families had installed a sound-to-light transducing device in the baby's crib which would flash a light if the baby's noises exceeded a given (adjustable) threshold. There was considerable variation in the efficacy of this arrangement. In two homes the flashing light (a floor lamp) was lighting up not only the entire bedroom but flashing directly in the baby's face. In another case, red lights would flash in the bedroom, the hall, and in the kitchen. This was the only home in which the device was used as a round-the-clock baby monitor. In the remaining five families, the light was left to flash throughout the day with baby noises, but the arrangement was such that the mother could not see it unless she happened to be looking into the room where the lamp was." [p. 25]

From the description of this arrangement it is apparent that the light was contingent upon noises that the child made and could have acted as a reinforcer for his vocalizations. There are several experiments in the literature which suggest that lights can be positive reinforcers for infant vocalizations. The previously reported experiment by Ramey and Watson (1970) reported such to be the case but only for 16-week-old males. While there are age differences between the infants used by Lenneberg et al. and those of Ramey and Watson it is also the case that the former's subjects had a much longer exposure to the potential reinforcer which might have aided learning. It is interesting in addition that in Ramey and Watson's experiment conditioning occurred only for males with light alone as reinforcement and that in the study by Lenneberg et al. 5 of the 6 infants who belonged to deaf parents were males.

Another experiment which provides evidence that visual reinforcement leads to conditioned vocalizations has been reported by Sheppard (1969), who was successful in maintaining high rates of vocal responding with an infant under 3-months over many experimental sessions using a flashing light and a tape recording of the voice of the child's mother. That Sheppard's reported increase of vocal responding (from a mean of 1.5 RPM during base-line to a mean of 12 RPM during the final conditioning session) was achieved through operant conditioning and not due to eliciting properties of the reinforcer was amply demonstrated by establishing "differential responding under discriminative control for both vocal and motor operants . . ." (p. 48). As Sheppard himself notes, however, the response rates which he reported are not directly comparable to other investigations because all sounds were automatically recorded and reinforced in his experiment and not just voiced sounds.

Finally the previously mentioned experiment by Ramey, Hieger, and Klisz (1971) provides evidence that light flashes can be used as positive reinforcement. However, their infants were between 7 and 14 months of age. Using a voice activated relay which controlled the onset and offset of a visual stimulator which when activated showed brightly colored geometric stimuli on a bright white background and a "cry over-ride" switch to preclude

reinforcement of fussy vocalizations, they were successful in significantly raising the mean vocalization rates from 3.75 RPM for baseline to 17.52 RPM during conditioning.

All of the studies which have just been mentioned, thus, seem to indicate that the voice-to-light transducer in Lenneberg, Rebelsky, and Nichols' study might well have served as a reinforcer for the children of the deaf parents.

Thus, the data from Lenneberg, Rebelsky, and Nichol's study fails to demonstrate that the infants of deaf parents receive less contingent vocal responding from their parents than do children of hearing parents and it further fails to take into account the possibility of the presence of other reinforcers either from the parents or from the transducing device. Therefore, their observation that "Probably, during the first three months of life, there is a minimum of voluntary control [of vocalization] and a close tie to autonomic functions" is simply unwarranted.

Role of Early Vocal Responses

Watson (1967) has advanced an hypothesis about the effects of early response-contingent stimulation which tangentially may be of importance in understanding the role of early vocalizations. He has suggested that the human infant is structured from birth for the processing of response-contingent information. However, during the first few months of life the "infant possesses few, if any, responses which both elicit rewarding stimulation directly from the physical environment and at the same time possess recovery speeds sufficient for the infant's initial level of contingency awareness." With respect to this last point Watson has hypothesized that at least two response-contingent sequences must occur within the infant's memory span in order for him to develop an initial awareness that his responses resulted in the change in external stimulation.

Whereas, Watson's main point concerns the effects of what he calls the natural deprivation period for contingency experiences his ideas by implication may offer some insights into early vocal development beyond the natural deprivation period as well. After working in the area of infant vocal behavior for some time I am struck by two aspects of that behavior. First, vocal responses are among the very first responses which the infant can control with any precision. Long before he has mastered locomotor skills or eye-hand coordination he apparently can control, at least, the onset of his non-fussy vocalizations. Second, the vocal response appears to be particularly fatigue-resistant as has been well documented by conditioning experiments which have reported sustained rates of as high as 8 to 17 responses per minute. (Rheingold, et al., 1959; Ramey and Ourth, 1971; Sheppard, 1969; Ramey, Hieger, and Klisz, 1971), depending on how a response is defined. Thus the vocal response is potentially a likely candidate for one that will result in response-contingent stimulation.

The consequences of increased response-contingent stimulation for vocal responding have only recently begun to be under investigation. Recently Ramey, Hieger, & Klisz (1971) have reported increased responsiveness and increased Cattell scores for maternally deprived infants who were subjected to operant conditioning procedures designed to increase vocal output. Thus it might be that early response-contingent vocal stimulation serves generally to enhance functional ability by serving as a prototype for control experiences generally. However, this study is based on a small number of children and must be interpreted with caution until the results from a larger intervention program which is currently getting under way are available.

Mother-Infant Interaction as a Prototype for Contingency Awareness

Watson and Ramey (1971) have suggested that within the interactional games that mothers play with their infants (e.g. responding to the infant with facial gestures, vocalization, etc. when, the infant makes a response) the infant comes to learn that he can control events in his environment or in Piaget's term reaches the stage of secondary circular reactions. What then would seem to be in order would be some exploratory studies which attempt to look at the behavioral correlates associated with varying amounts of response-contingent stimulation in mother-infant interaction patterns.

A review of the literature indicates that there is precious little research in the literature which actually deals with mother-infant interactions. Much of the research has used mothers' reports as the primary data for analysis and to a lesser degree there has been actual observation of both mothers and infants simultaneously. Although there have been several research attempts to deal with the infant's behavior, in the presence of the mother (Schaffer and Emerson, 1964; Ainsworth, 1963; Lewis, 1971; Wahler, 1969; Lewis and Wilson, 1971; Lewis and Goldberg, 1969; and Moss, 1967) very little of this research has been able to deal with the notion of reciprocity of mother-infant behavior which is implied in the term interaction and investigators continue to search for appropriate statistical or mathematical models to describe on-going reciprocal behaviors. Further, as Lewis (1971) has pointed out "It is often difficult to determine exactly which one of the pair initiates a behavior sequence and time duration of the sequence."

That mother-infant interaction is an important component of early infant development is a point with which few theorists or researchers would quarrel. Indeed, the reduced opportunity for such stimulation has been explicitly or implicitly implied to account for the developmental retardation of institutionalized babies (see e.g. Spitz, 1945; Bowlby, 1959; Goldfarb, 1945; Rheingold and Bayley, 1959).

The interaction studies which seem most relevant to the understanding of vocal behavior are those by Moss (1967), Wahler (1969), Lewis and Wilson (1971), and Rheingold and Bayley (1959).

Moss (1967) observed mother-infant interactions in the homes of 30 first-born children during the first 3 months of life. He was able to show that there was a significant correlation between the frequency of talking that a mother did to her infant at 3 weeks and at 3 months. In addition there was also a significant correlation between the amount of vocalizing that an infant engaged in at each of these measurement times. Although one certainly cannot draw any firm cause and effect relationship from these data it is tempting to hypothesize that infants who vocalize more have mothers who are more responsive. However, since these data are not based upon true interactional analyses a number of alternative hypotheses are also possible.

Lewis and Wilson (1971) have provided some data which tend to support this hypothesis and which also raises the possibility that the type of response that a mother makes contingent upon the child's vocalizations may be important. They report that although there is no overall difference in the responsiveness of mothers from various social classes "the middle SES mother responds to her infant's vocalizations with a vocalization, which this is less true for the lower SES mother. It is to be noted that this same behavior is found toward girls versus boy infants, the girls' vocalization resulting in more maternal vocalization than boys'". As Lewis also points out "That girls and middle SES subjects have faster language acquisition may be no coincidence."

Wahler (1969) has conducted an experiment on a single male infant throughout the first year of life. He provides evidence to indicate that the mother's contingent social attention was an effective reinforcement for selectively conditioning sub-classes of the infant's vocalizations in a naturalistic setting. Further, vocal responses which did not belong to the class to be reinforced declined in relative frequency.

Finally, Rheingold and Bayley (1959) provide some intriguing information which appears to indicate that the vocal response may be a particularly sensitive response to response-contingent stimulation. They report a follow-up study of 14 previously institutionalized infants, half of whom had received additional care by one of the experimenters between the sixth and eighth month of life. Although no other measure of social responsiveness that the authors used could differentiate the infants who had received the extra care from those who had not, vocal responsiveness during the home assessments favored the additional care group. Further, it is interesting to note that the experimental group vocalized significantly more than the control group at the end of the initial intervention period also. In light of other writings by Rheingold it is quite unlikely that the supplementary social stimulation which she provided for the experimental group would have been non-contingent in nature. However, the role of response-contingent stimulation on vocal development is still somewhat speculative and the long-term consequences of enriched response-contingent stimulation on vocal behavior warrants further investigation.

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Footnotes

[1]Now at the Frank Porter Graham Child Development Center University of North Carolina, Chapel Hill, North Carolina.